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EVALUATION OF THE EFFECTS OF ASA-3 ON THE PERFORMANCE OF MILITA--ETC(U)
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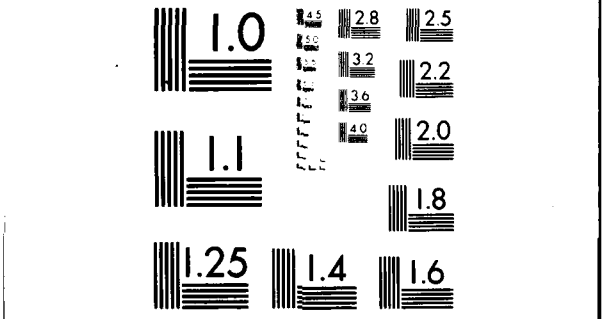

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Report 2290

EVALUATION OF THE EFFECTS OF ASA-3 ON THE PERFORMANCE OF MILITARY STANDARD FILTER/COALESCER ELEMENTS

by
Ralph J. Polk, Jr.
and
William R. Williams

February 1980

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U.S. ARMY MOBILITY EQUIPMENT
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This report covers decontamination tests conducted on military standard filter/coalescer elements using JP-4 and JP-5 turbine fuels with and without antistatic additive ASA-3.

During the tests, JP-5 with ASA-3 degraded filter/coalescer element performance; JP-4 with ASA-3 had a negligible effect on filter/coalescer element performance.

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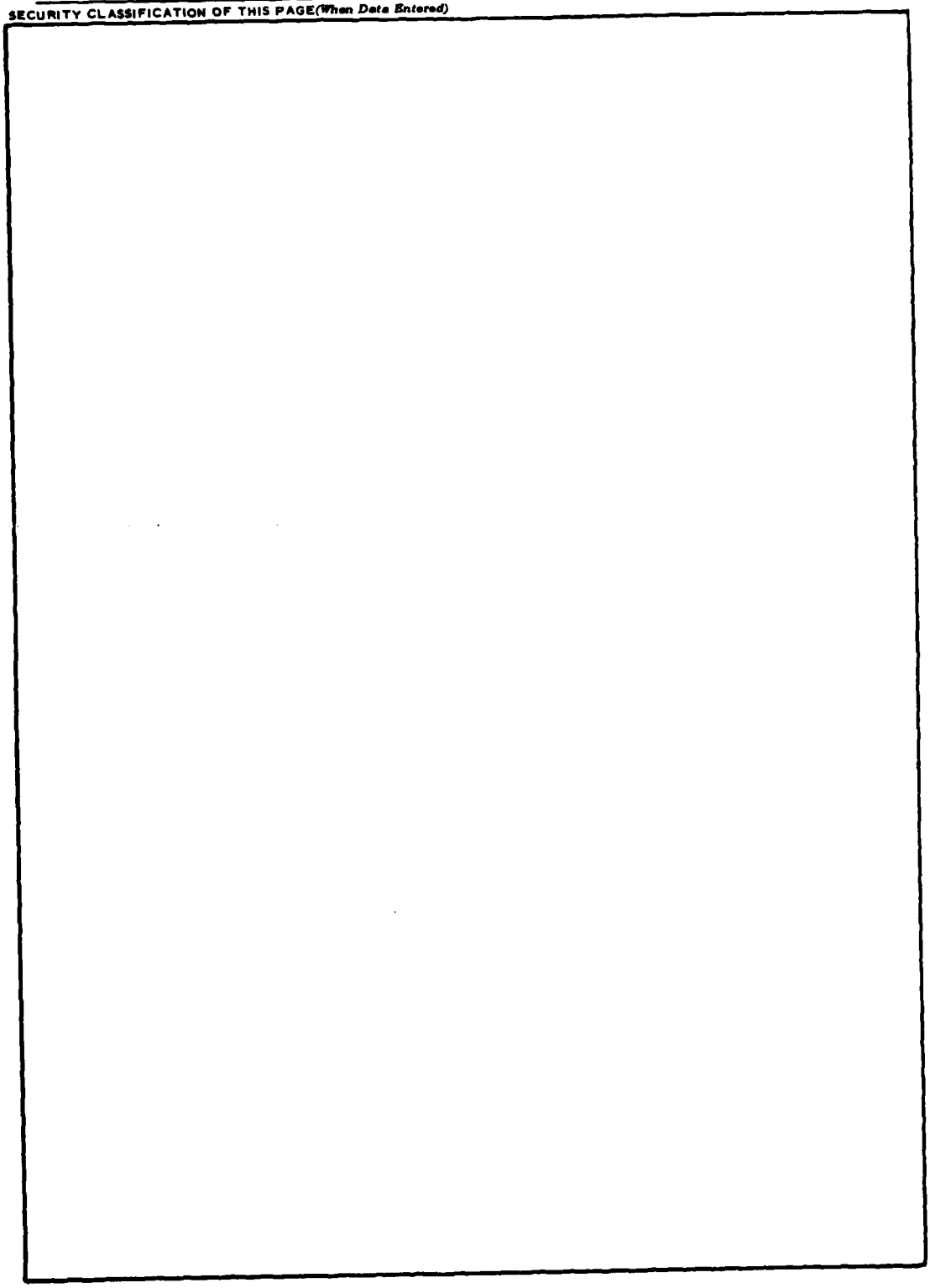

PREFACE

Authority for conducting the research described in this report is contained in the Catalog of Approved Requirement Documents (CARDS) under Project No. 1G762708AH67.

Tests were conducted during September to October 1978 in the POL Test Facility; MERADCOM; Fort Belvoir, Virginia.

The work was conducted under the joint supervision of M. E. LePera, Chief, Fuels and Lubricants Division and N. A. Caspero, Chief, Engineering Division; Energy and Water Resources Laboratory; MERADCOM; Fort Belvoir, Virginia.

The following MERADCOM personnel participated in the test program:

William R. Williams, Chemical Engineer.
Ralph J. Polk, Jr., Engineering Technician.
Conrad Korzendorfer, Engineering Technician.
William J. Johnston, Engineering Technician.

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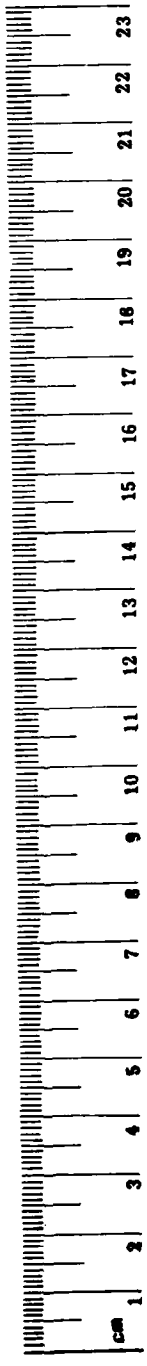
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

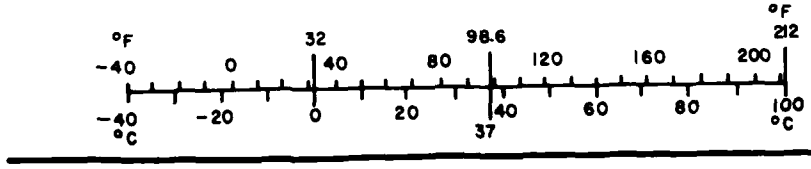
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric tons	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* 1 in = 2.54 cm (exactly)



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric tons (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EVALUATION OF THE EFFECTS OF ASA-3 ON THE PERFORMANCE OF MILITARY STANDARD FILTER/COALESCER ELEMENTS

I. INTRODUCTION

1. **Subject.** This report covers decontamination tests conducted on military standard filter/coalescer elements using JP-4 and JP-5 turbine fuels with and without the antistatic additive, ASA-3.

2. **Background.** Numerous instances of electrostatic discharges during aircraft refueling have led to the development of fuel additives that act to inhibit charge formation and increase fuel conductivity. Two of these antistatic additives were investigated by the Air Force: Shell ASA-3 and Dupont Stadis 450. In 1976 the Air Force made the use of an antistatic additive optional for use in turbine fuel. Recently this was changed to mandatory use in JP-4 as specified in Military Specification MIL-T-5624L. The only approved additive currently is ASA-3; Stadis 450 presents problems at low temperatures. As part of the Air Force investigation, MERADCOM conducted some limited testing in 1977 to determine the effect of the use of the antistatic additive on the performance of filter coalescers. Those tests were performed with both ASA-3 and Stadis 450 using JP-5 fuel, which is the designated fuel for filtration tests. Results of these tests were inconclusive but indication was that ASA-3 acted to degrade performance of filter coalescers. Consequently, a more thorough test program was necessary using both JP-4 and JP-5 and based upon the procedures outlined in Military Specification MIL-F-8901, "Filter-Separators, Liquid Fuels: and Filter-Coalescer Elements, Fluid Pressure: Inspection Requirements and Test Procedures for."

II. INVESTIGATION

3. **Test Procedures and Equipment.** Appropriate test procedures were selected from MIL-F-8901 and performed on military standard filter/coalescer elements using two batches of fuel for each test: one batch with ASA-3 and one batch without. To save time, some past data were used to represent the "without" batches on JP-5. ASA-3 was added to the supply tank at about 0.7 parts per millon (p/m) or at sufficient levels to attempt to bring up the fuel conductivity levels from a normal value of 10 to 20 pS/m to approximately 100 pS/m.

The test facility is that described in MIL-F-8901. The continuously recirculating pumping loop is shown in Figure 1. The fuel is recirculated using a nominal

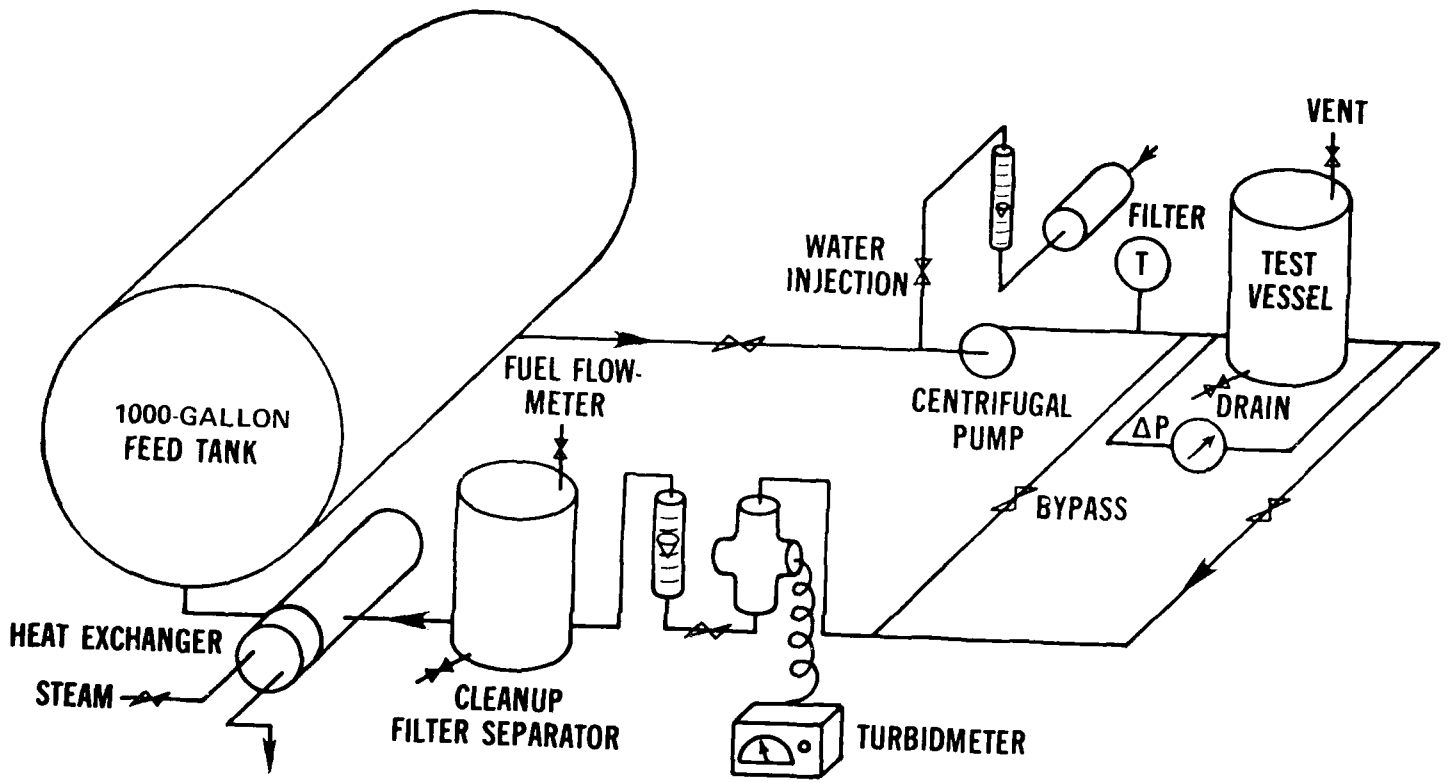


Figure 1. Test facility — 50-gal/min pumping loop.

50-gal/min centrifugal pump with a flow adjustable over the range of 10- to 50-gal/min. Water and solids contaminant is injected just upstream of the pump resulting in a stable emulsion which represents the influent to the test filter separator. Appropriate gauges measure flow, temperature, and pressure drop across the test filter separator. A flow-type turbidimeter was used to measure the amount of water in the effluent. The turbidimeter (Keene model 861-C) was calibrated to read suspended water over the range of 0 to 5000 p/m. Solids were determined by sampling the effluent and running a 0.8μ millepore analysis. A cleanup filter separator was used to remove any residual water or solids before the fuel was returned to the 1000-gal supply tank. A heat exchanger controlled fuel temperature to ± 5°F. This configuration was used in all tests except the Inhibited Fuel Tests, in which the fuel is allowed to make only a single pass from one tank to another to prevent continuous removal of the inhibiting additives.

4. **Fuels and Contaminants.** Test fuels conformed to the requirements of MIL-T-5624, "Turbine Fuel, Aviation Grades JP-4 and JP-5." Pertinent specifications are as follows:

Fuel: MIL-T-5624.
WSIM: 90 (min), ASTM D2550.
IFT (dynes/cm): 40 (min), ASTM D1331, Method B.
Conductivity (pS/m): 100 (min), ASTM D2624.

The water injected into the fuel during the tests was supplied by the Fort Belvoir water utility system. Prior to use, the water is filtered to a residual solids level of less than 1 mg/l.

The solid contaminants used were finely divided red iron oxide (Fe_2O_3) obtained from Fisher Scientific (Cat. No. I-116) and Siliceous dust (AC test dust) obtained from the AC Spark Plug Co. (Cat. No. 1543637).

5. **Filter/Coalescer Elements.** The filter/coalescer elements used meet the requirements of Specifications MIL-F-8901 and MIL-F-52308 and are standard DoD items listed under NSN 4330-00-983-0998. The test elements were manufactured by Velcon Filters, Incorporated. Two elements were used in the test filter separator and as each is rated at 20 gal/min, the total nominal flow rate is 40 gal/min.

6. **Significance of Tests.** The following tests were performed using JP-4 and JP-5 both with and without ASA-3.

a. **Differential Pressure and Media Migration.** This test determines the amount of media migration, fiber migration, and pressure drop across the filter/coalescer elements under various flow rates but without adding any contaminants.

b. **Red Iron Oxide (Dry).** This test allows for injection of red iron oxide at a fixed rate and at a fixed fuel flow rate to determine the time necessary to reach a pressure drop of 75 lb/in^{2}g and to determine the amount of solids passed through the effluent. The test is also used to determine the structural strength of the element.

c. **Water Removal.** The water removal tests consist of three 1-hour runs at 115 percent of rated flow. Water is injected at the rate of 0.5 percent in the first hour, 5 percent in the second hour, and 10 percent in the third hour. The purpose is to measure water removal efficiency by measurement of the water in the effluent.

d. **Red Iron Oxide and Water.** This test involves the injection of both water and red iron oxide at rated flow. Its purpose is to determine the solids-holding capacity of the coalescer elements in conjunction with water removal ability versus pressure drop. The test is continued until a 40-lb/in^{2}g differential pressure is reached.

e. **Inhibited Fuel.** The test loop is modified for this test to allow for a single pass flow. The fuel is inhibited, using corrosion inhibitor (HITEC-515) (conforming to MIL-I-25017) at a concentration of 16 pounds per 1000 barrels and 0.15 percent icing inhibitor (FSII) conforming to MIL-I-27686. Both of these inhibitors act to decrease the Water Separation Index (Modified) (WSIM) and the coalescing ability of the filter/coalescer elements. For the first 70 minutes, water is added at one percent; then water and AC test dust are injected for the remaining 60 minutes.

f. **Post Environmental.** The purpose of this test is to determine filter/coalescer element degradation after being subjected to a fuel immersion test (100 hours), a salt water immersion test (72 hours), and a high- and low-temperature cycle (+160°F and -50°F). Water is injected at a rate of 0.5 percent for a period of 1 hour.

III. DISCUSSION

7. **Discussion of Results.** Results of all tests are tabulated in Tables 1 through 10 and are shown graphically, where possible, in Figures 2 through 10.

In almost all instances, ASA-3 in JP-5 degrades the performance of filter/coalescer elements. The effluent water and solids are significantly higher in every test. The pressure drop tends to be higher when ASA-3-laden fuel is used. In many instances, the amount of degradation is sufficient to cause failure to meet the requirements of MIL-F-8901. There is also a possible synergistic effect between the ASA-3 and the fuel inhibitors. On the other hand, the effect of ASA-3 in JP-4 is practically negligible.

Table 1. Test Series I

Test Fuel: Turbine Fuel, Aviation, Grade JP-5; MIL-T-5624
Test: Differential Pressure and Media Migration; MIL-F-8901, para 4.4.3.6
Filter Element: Velcon I – 4208B

Test Conditions			Test: Ia, JP-5 w/ASA-3 Element Lot: 27 Oct 76					Test: Ib, JP-5 w/o ASA-3 Element Lot: QPL			
Time (min)	Flow (gal/min)	Rated Flow (%)	Fuel Temp (°F)	Differential Pressure (lb/in²g)	Effluent Solids (mg/l)	Effluent Fibers (No. 1)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in²g)	Effluent Solids (mg/l)	Effluent Fibers (No. 1)
0	40	100	85	3.0	*	*	*	*	*	*	*
5	40	100	85	3.5	0.37	3	*	73	1.9	*	*
10	40	100	86	3.5	1.81**	2	80	74	2.0	0	2
20	32	80	87	3.2	6.77**	3	70	74	1.6	0.2	2
30	24	60	88	2.5	2.92**	3	60	76	1.3	0.5	0
40	16	40	90	2.0	2.99**	4	80	79	0.9	0.8	1
50	8	20	97	1.5	3.44**	3	90	85	0.4	0	1
60	46	115	88	4.5	0.22	8	70	78	2.8	0	1
		Avg:	88.7	3.0	2.96**	3.7		77	1.56	0.25	1.2
		WSIM before test:				98				90	
		IFT before test:				38.2				43.4	
		Conductivity before test:									
		before ASA-3 addition:				5					
		after ASA-3 addition:				120					

* No data.
** Exceeds specification limit.

Table 2. Test Series II

Test Fuel: Turbine Fuel, Aviation Grade JP-5, MIL-T-5624
Test: Red Iron Oxide (Dry); MIL-F-8901, para 4.4.3.7
Filter Element: Velcon I – 4208B

Test Conditions				Test IIa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test IIb, JP-5 w/o ASA-3 Element Lot: QPL		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)
0	40	100	0	89	5.0	*	50	80	2.5	*
5	40	100	0.143	89	5.0	6.46**	*	80	2.5	0.1
10	40	100	0.143	89	5.0	7.67**	40	80	2.5	0
20	40	100	0.143	89	5.0	6.13**	33	80	2.5	0
30	40	100	0.143	90	5.0	8.51**	23	80	2.7	0
40	40	100	0.143	90	5.0	6.82*	17	81	2.8	0
50	40	100	0.143	90	5.0	1.66*	*	81	3.0	0
60	40	100	0.143	90	5.0	1.84*	11	82	3.0	0
70	40	100	0.143	90	5.0	4.75*	10	82	3.0	0.1
80	40	100	0.400	90	5.0	0.15	10	83	3.2	0
90	40	100	0.400	90	5.0	0.98*	9	83	6.0	0.6
100	40	100	0.400	91	8.0	3.98*	9	83	13.5	0.1
110	40	100	0.400	91	14.0	*	9	84	29.0	0
112	40	100	0.400	*	*	*	9	84	40.0	0.2
120	40	100	0.400	91	25.5	2.35**	*	84	68.0	0.9
121	40	100	0.400	*	*	*	*	84	75.0	0
126	40	100	0.400	91	40.0	3.51**	*	84	75.0	0.2
127	40	100	0.400	91	45.0	*	*		End of Test	
127.5	40	100	0.400	91	50.0	*	*			

Table 2. Test Series II (Continued)

Test Fuel: Turbine Fuel, Aviation Grade JP-5, MIL-T-5624
Test: Red Iron Oxide (Dry); MIL-F-8901, para 4.4.3.7
Filter Element: Velcon I – 4208B

Test Conditions				Test IIa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test IIb, JP-5 w/o ASA-3 Element Lot: QPL		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)
128	40	100	0.400	91	55.0	2.53**	*			
130	40	100	0.400	92	60.0	*	8			
131	40	100	0.400	92	65.0	*	*			
132	40	100	0.400	92	75.0	*	*			
			Avg:	90.4	23.45	4.10**		82.1	19.66	0.14
			WSIM before test:			98				

* No data.
** Exceeds specification limit.

Table 3. Test Series III

Test Fuel: Turbine Fuel, Aviation Grade JP-5; MIL-T-5624
Test: Water Removal; MIL-F-8901, para 4.4.3.8
Filter Element: Velcon I – 4208B

Test Conditions				Test IIIa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test IIIb, JP-5 w/o ASA-3 Element Lot: QPL		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)
0	46	115	0	87	3.5	*	110	81	3.0	*
10	46	115	0.5	87	6.9	0	28	81	4.5	0
20	46	115	0.5	87	8.0	0	28	81	5.0	0
30	46	115	0.5	87	8.5	0	27	82	5.6	0
40	46	115	0.5	88	8.8	0	29	83	6.0	0
50	46	115	0.5	88	9.1	0	25	83	6.4	0
60	46	115	0.5	88	9.2	0	26	84	6.6	0
70	46	115	5.0	87	10.5	0.3	30	74	8.6	0.6
80	46	115	5.0	87	10.8	0.3	27	74	9.2	0.7
90	46	115	5.0	87	11.2	0.3	26	75	10.0	0.6
100	46	115	5.0	87	11.5	0.4	26	77	10.0	0.6
110	46	115	5.0	87	11.8	0.4	26	77	10.0	0.7
120	46	115	5.0	86	11.9	0.8	24	77	10.3	0.5
130	46	115	10.0	86	12.5	2.0	25	79	10.0	0.7
140	46	115	10.0	86	12.9	3.0	26	80	10.5	0.5
150	46	115	10.0	86	13.1	3.6	24	80	11.0	0.5
160	46	115	10.0	86	13.3	4.0	24	80	11.0	0.5
170	46	115	10.0	86	13.5	4.4	26	80	11.1	0.6
180	46	115	10.0	86	13.7	5.2**	25	80	11.5	0.5
			Avg:	86.9	10.56	1.62		79.4	8.4	0.39

* No data.
** Exceeds specification limit.

Table 4. Test Series IV

Test Fuel: Turbine Fuel, Aviation Grade JP-5; MIL-T-5624
Test: Red Iron Oxide and Water; MIL-F-8901, para 4.4.3.9
Filter Element: Velcon I – 4208B

Test Conditions					Test IVa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test IVb, JP-5 w/o ASA-3 Element Lot: QPL			
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)
0	40	100	0	0	83	6.0	*	*	84	5.0	*	*
5	40	100	3.0	0.143	83	9.8	0.1	0.09	84	7.5	0.2	0.1
10	40	100	3.0	0.143	84	10.2	0	7.85**	84	8.0	0.1	0.1
20	40	100	3.0	0.143	84	10.7	0.1	49.47**	84	8.7	0.1	0
30	40	100	3.0	0.143	84	11.3	0	0.01	84	9.1	0	0
40	40	100	3.0	0.143	84	12.0	0.1	2.19**	85	9.5	0	0.1
50	40	100	3.0	0.143	84	12.9	0	0.01	85	10.4	0	0.1
60	40	100	3.0	0.143	84	13.8	0	3.16**	85	10.8	0	0
70	40	100	3.0	0.143	84	14.5	0	0.85	85	11.2	0	0
100	40	100	3.0	0.143	*	*	*	*	86	13.2	0	*
110	40	100	3.0	0.143	*	*	*	*	85	14.0	0	0.1
115	40	100	3.0	0.143	84	19.5	0	2.15**	*	*	*	*
130	40	100	3.0	0.143	*	*	*	*	85	16.4	0	*
140	40	100	3.0	0.143	85	24.5	0	3.68**	*	*	*	*
150	40	100	3.0	0.143	*	*	*	*	85	20.0	0	0
160	40	100	3.0	0.143	85	29.5	0.1	0.13	85	22.5	0	*
170	40	100	3.0	0.143	*	*	*	*	85	25.0	0	0
180	40	100	3.0	0.143	85	35.0	0.4	0.01	85	28.5	0	*

Table 4. Test Series IV (Continued)

Test Fuel: Turbine Fuel, Aviation Grade JP-5; MIL-T-5624
Test: Red Iron Oxide and Water; MIL-F-8901, para 4.4.3.9
Filter Element: Velcon I – 4208B

Test Conditions					Test IVa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test IVb, JP-5 w/o ASA-3 Element Lot: QPL			
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent H_2O (p/m)	Effluent Solids (mg/l)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent H_2O (p/m)	Effluent Solids (mg/l)
190	40	100	3.0	0.143	85	40.0	0.2	0.05	85	33.0	0	0.1
195	40	100	3.0	0.143	*	*	*	*	85	40.0	0	0
				Avg:	84.1	17.84	0.08	5.36**	84.8	20.02	0.02	0.05
			WSIM before test:					98				

* No data.
** Exceeds specification limit.

Table 5. Test Series V

Test Fuel: Inhibited Turbine Fuel, Aviation Grade JP-5; MIL-T-5624 inhibited with 16 lb/1000 bbl of HITEC E-515 and 0.15% FSII
Test: Inhibited Fuel, para 4.4.3.10
Filter Element: Velcon I – 4208B

Test Conditions					Test Va, inhibited JP-5 w/ASA-3 Element Lot: 27 Oct 76					Test Vb, inhibited JP-5 w/o ASA-3 Element Lot: QPL			
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Injected AC Dust (g/gal)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)
0	40	100	*	0	74	6.9	*	*	130	84	6.3	*	*
5	40	100	1.0	0	74	9.7	0.2	*	34	84	8.8	0	*
10	40	100	1.0	0	74	10.2	0.5	*	32	84	10.0	0	*
20	40	100	1.0	0	74	10.5	0.6	*	33	84	11.0	0	*
30	40	100	1.0	0	74	10.7	0.8	*	34	84	11.6	0	*
40	40	100	1.0	0	74	10.8	0.9	*	35	84	12.0	0	*
50	40	100	1.0	0	74	10.9	0.9	*	37	84	12.3	0	*
60	40	100	1.0	0	74	10.9	1.2	*	36	84	12.5	0.1	*
65	40	100	1.0	0.143	74	11.1	1.1	3.16**	38	84	12.8	0.1	0.3
70	40	100	1.0	0.143	74	11.2	1.1	1.57**	39	84	13.0	0.1	0.3
80	40	100	1.0	0.143	74	11.6	1.1	0.41	80+	84	13.3	0.1	0
90	40	100	1.0	0.143	74	12.1	1.2	0	80	84	13.8	0.1	0.9
100	40	100	1.0	0.143	74	12.8	1.3	0.72	110	84	14.3	0.2	0
110	40	100	1.0	0.143	74	13.3	1.5	0.27	95	84	14.8	0.2	0.2
120	40	100	1.0	0.143	74	14.0	1.6	2.95**	100	84	15.3	0.2	0
130	40	100	1.0	0.143	74	14.8	1.8	0.24	90	84	15.8	0.2	0.1
				Avg:	74	11.34	1.05	1.16**		84	12.35	0.09	0.22

WSIM before adding inhibitors:	97	94
WSIM before test:	30	34
WSIM after test:	41	66
IFT before adding inhibitors:	29.4	43.9
IFT before test:	15.8	31.5
IFT after test:	32.1	32.3
Water pH:	7.30	6.70

* No data.
** Exceeds specification limit.
+ Instrument anomaly.

Table 6. Test Series VI

Test Fuel: Turbine Fuel, Aviation Grade JP-5; MIL-T-5624
Test: Post Environmental; MIL-F-8901, para 4.4.3.17
Filter Element: Velcon I – 4208B

Test Conditions				Test IVa, JP-5 w/ASA-3 Element Lot: 27 Oct 76				Test VIb, JP-5 w/o ASA-3 Element Lot: QPL		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)
0	46	115	0	79	4.3	*	*	83	3.0	*
10	46	115	0.5	79	7.9	0.1	*	83	4.4	0
20	46	115	0.5	80	8.3	0.1	*	83	4.8	0
30	46	115	0.5	81	8.8	0.1	*	83	5.3	0
40	46	115	0.5	82	9.2	0.1	*	84	6.0	0
50	46	115	0.5	82	9.5	0.1	*	84	6.3	0
60	46	115	0.5	83	9.8	0.1	*	84	6.8	0
			Avg:	80.9	8.26	0.1		83.4	5.23	0

* No data.

Table 7. Test Series VII

Test Fuel: Turbine Fuel, Aviation Grade JP-4; MIL-T-5624
Test: Differential Pressure and Media Migrations; MIL-F-8901, para 4.4.3.6
Filter Element: Velcon I – 4208B; Lot: 27 Oct 76

Test Conditions			Test VIIa, JP-4 w/ASA-3					Test VIIb, JP-4 w/o ASA-3			
Time (min)	Flow (gal/min)	Rated Flow (%)	Fuel Temp (°F)	Differential Pressure (lb/in²g)	Effluent Solids (mg/l)	Effluent Fibers (No. 1)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in²g)	Effluent Solids (mg/l)	Effluent Fibers (No. 1)
0	40	100	58	1.0	*	*	*	68	1.5	*	*
5	40	100	58	1.0	0	2	*	68	1.5	0	4
10	40	100	58	1.0	0	14	70	68	1.5	0	2
20	32	80	59	0.8	0	7	*	69	1.5	0	2
30	24	60	61	0.5	0	1	10	71	1.5	0	3
40	16	40	64	0.2	0	3	*	73	1.0	0	4
50	8	20	69	0	0	3	*	77	0.5	0	8
60	46	115	62	1.5	0	0	48	70	1.5	0	4
		Avg:	61.1	0.75	0	4.3		70.5	1.31	0	3.9
			WSIM before test:			99		92			
			IFT before test:			38.6		40.9			
			Conductivity:								
			Before test:			3					
			After ASA-3 addition:			145					

* No data.

Table 8. Test Series VIII

Test Fuel: Turbine Fuel, Aviation Grade JP-4; MIL-T-5624
Test: Red Iron Oxide (Dry); MIL-F-8901, para 4.4.3.7
Filter Element: Velcon I – 4208B; Lot: 27 Oct 76

Test Conditions				Test VIIIa, JP-4 w/ASA-3				Test VIIIb, JP-4 w/o ASA-3		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure ($lb/in^2 g$)	Effluent Solids (mg/l)
0	40	100	0	62	1.2	*	50	67	2.1	*
5	40	100	0.143	62	1.3	0	*	68	2.3	0
10	40	100	0.143	62	1.3	0	*	68	2.3	0
20	40	100	0.143	63	1.4	0	47	69	2.3	0
30	40	100	0.143	64	1.4	0	*	70	2.3	0
40	40	100	0.143	65	1.5	0	29	72	2.3	0
50	40	100	0.143	66	1.5	0	*	72	2.3	0
60	40	100	0.143	66	1.5	0	28	72	2.3	0
70	40	100	0.143	67	1.7	0	*	72	2.3	0
80	40	100	0.40	68	1.7	0	20	72	2.5	0
90	40	100	0.40	69	2.3	0	*	72	3.3	0
100	40	100	0.40	69	4.3	0	19	72	5.9	0
110	40	100	0.40	70	8.5	0	*	73	12.0	*
120	40	100	0.40	71	16.5	*	12	73	22.3	0
130	40	100	0.40	71	32.0	0	*	73	40.0	0
130	40	100	0.40	*	*	*	*	73	45.0	*
132	40	100	0.40	71	40.0	*	*	73	50.0	0
134	40	100	0.40	71	45.0	0	*	73	55.0	*
135	40	100	0.40	71	*	*	*	73	60.0	0
136	40	100	0.40	71	55.0	0	*		End of Test	

Table 8. Test Series VIII (Continued)

Test Fuel: Turbine Fuel, Aviation Grade JP-4; MIL-T-5624
Test: Red Iron Oxide (Dry); MIL-F-8901, para 4.4.3.7
Filter Element: Velcon I - 4208B; Lot: 27 Oct 76

Test Conditions				Test VIIIa, JP-4 w/ASA-3				Test VIIIb, JP-4 w/o ASA-3		
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent Solids (mg/l)
137	40	100	0.40	71	60.0	*	*			
138	40	100	0.40	72	65.0	*	*			
139	40	100	0.40	72	70.0	*	*			
140	40	100	0.40	72	75.0	0	14			
			Avg:	68.1	22.19	0		71.4	16.66	0

* No data.

Table 9. Test Series IX

Test Fuel: Turbine Fuel, Aviation Grade JP-4; MIL-T-5624
Test: Water Removal; MIL-F-8901, para 4.4.3.8
Filter Element: Velcon I 4208B; Lot: 27 Oct 76

Test Conditions				Test IXa, JP-4 w/ASA-3				Text IXb, JP-4 w/o ASA-3		
Time (min)	Flow (gal min)	Rated Flow (%)	Injected H_2O (%)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)
0	46	115	0	60	1.7	*	50	75	2.3	*
10	46	115	0.5	60	5.8	0	*	75	6.7	0
20	46	115	0.5	61	6.5	0.1	65	76	7.8	0
30	46	115	0.5	62	6.8	0.1	*	77	8.2	0
40	46	115	0.5	63	7.0	0.1	*	77	8.3	0
50	46	115	0.5	64	7.2	0.1	*	77	8.5	0
60	46	115	0.5	66	7.3	0.1	65	77	8.5	0
70	46	115	5.0	66	8.3	0.1	*	67	10.2	0.1
80	46	115	5.0	67	8.8	0.1	60	68	10.2	0.1
90	46	115	5.0	67	9.2	0.1	*	68	10.2	0.1
100	46	115	5.0	68	9.3	0.1	65	69	10.2	0.1
110	46	115	5.0	68	9.7	0.1	*	69	10.2	0.1
120	46	115	5.0	68	9.8	0.1	50	69	10.2	0.2
130	46	115	10.0	68	10.2	0.2	*	69	10.3	0.2
140	46	115	10.0	68	10.5	0.1	50	69	10.5	0.2
150	46	115	10.0	68	10.8	0.1	*	69	10.7	0.2
160	46	115	10.0	68	11.0	0.1	50	69	10.8	0.2
170	46	115	10.0	68	11.2	0.1	*	69	10.8	0.2
180	46	115	10.0	68	11.2	0.1	48	69	10.8	0.2
			Avg:	65.7	8.54	0.10		71.5	9.23	0.11

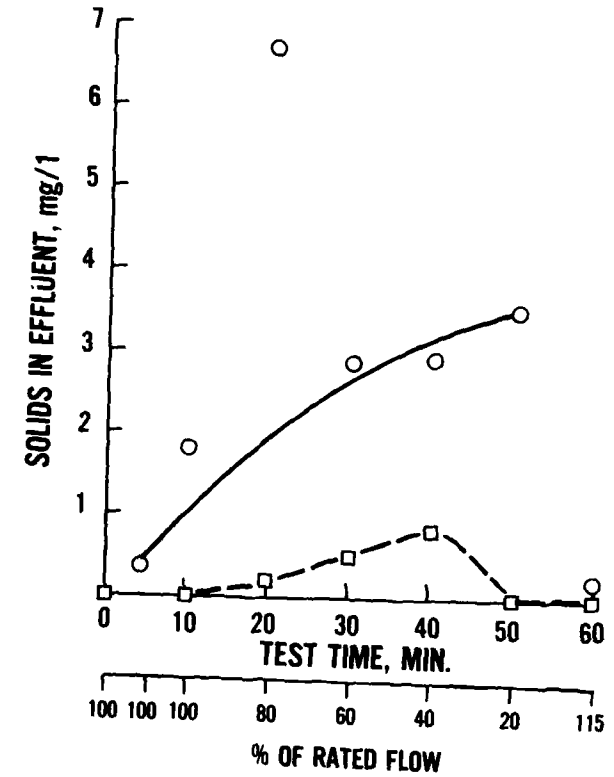
* No data.

Table 10. Test Series X

Test Fuel: Turbine Fuel, Aviation Grade JP-4; MIL-T-5624
Test: Red Iron Oxide and Water; MIL-F-8901, para 4.4.3.9
Filter Element: Velcon I – 4208B; Lot: 27 Oct 76

Test Conditions					Test Xa, JP-4 w/ASA-3					Test Xb, JP-4 w/o ASA-3				
Time (min)	Flow (gal/min)	Rated Flow (%)	Injected H_2O (%)	Injected Fe_2O_3 (g/gal)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)	Effluent Conductivity (pS/m)	Fuel Temp (°F)	Differential Pressure (lb/in^2g)	Effluent H_2O (p/m)	Effluent Solids (mg/l)	
0	40	100	0	0	63	4.9	*	*	70	61	4.8	*	*	
5	40	100	3.0	0.143	63	7.6	0	0	*	61	9.0	0.2	0	
10	40	100	3.0	0.143	63	9.0	0	0	*	61	9.7	0.2	0	
20	40	100	3.0	0.143	64	10.0	0	0	60	61	10.3	0.2	0	
30	40	100	3.0	0.143	64	10.6	0	0	*	62	11.0	0.2	0	
40	40	100	3.0	0.143	65	11.5	0	0	50	63	11.9	0.2	0	
50	40	100	3.0	0.143	66	12.3	0	*	*	63	12.9	0.2	0	*
60	40	100	3.0	0.143	66	13.0	0	0	55	64	14.2	0.2	0	
70	40	100	3.0	0.143	67	14.0	0	0	*	64	15.5	0.2	0	
80	40	100	3.0	0.143	68	15.0	0	0	55	65	17.3	0.2	0	
90	40	100	3.0	0.143	68	19.3	0	0	48	65	22.5	0.2	0	
95	40	100	3.0	0.143	*	*	*	*	*	66	28.0	0.2	0	
100	40	100	3.0	0.143	69	25.0	0	*	50	66	33.0	0.2	0	
103	40	100	3.0	0.143	*	*	*	*	*	66	38.0	0.2	*	
104	40	100	3.0	0.143	*	*	*	*	*	66	40.0	0.2	*	
108	40	100	3.0	0.143	69	30.0	0	0	*		End of Test			
112	40	100	3.0	0.143	69	35.0	0	*	*					
118	40	100	3.0	0.143	69	40.0	0	0	49					
				Avg:	66.2	17.15	0	0		63.6	18.54	0.20	0	

* No data.



TEST SERIES I
DIFFERENTIAL PRESS
& MEDIA MIGRATION
MIL-F-890 1D PARA 4.4.3.6
TEMP 70-90°F
RATED FLOW 40 GPM

□— — NEAT JP-5
O—— JP-5 w/0.7 ppm ASA-3

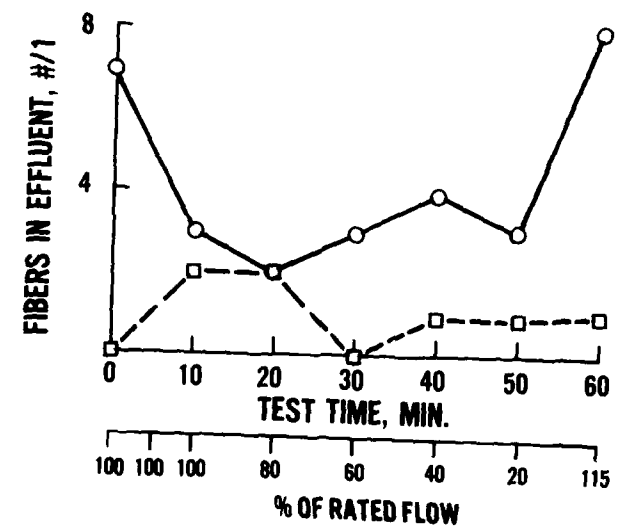


Figure 2. Test Series I, JP-5.

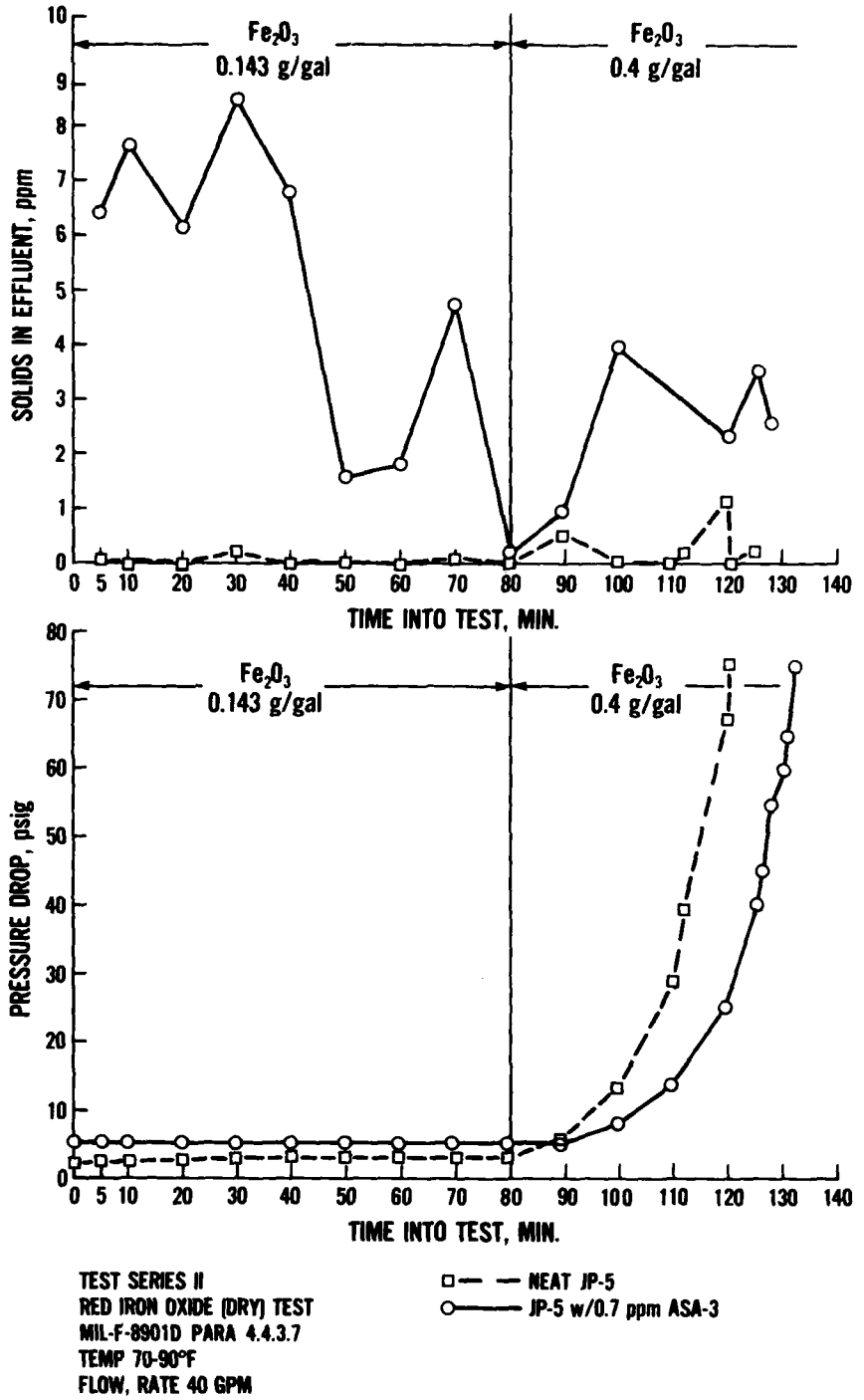


Figure 3. Test Series II, JP-5.

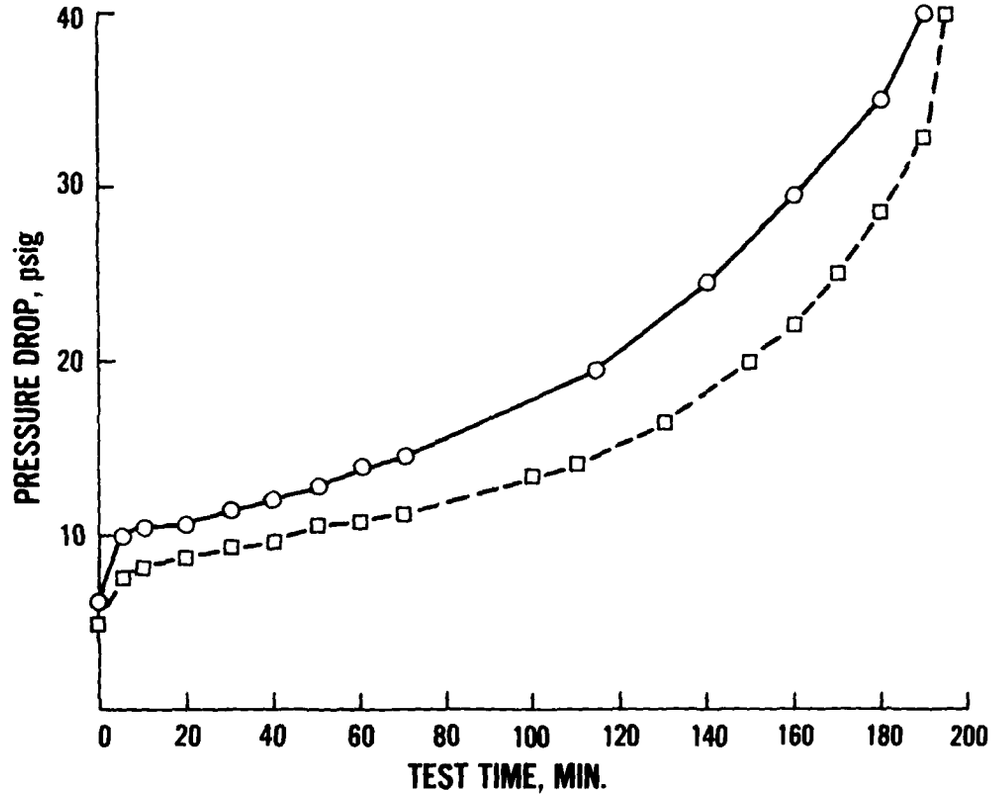


Figure 3. Test Series II, JP-5 (continued).

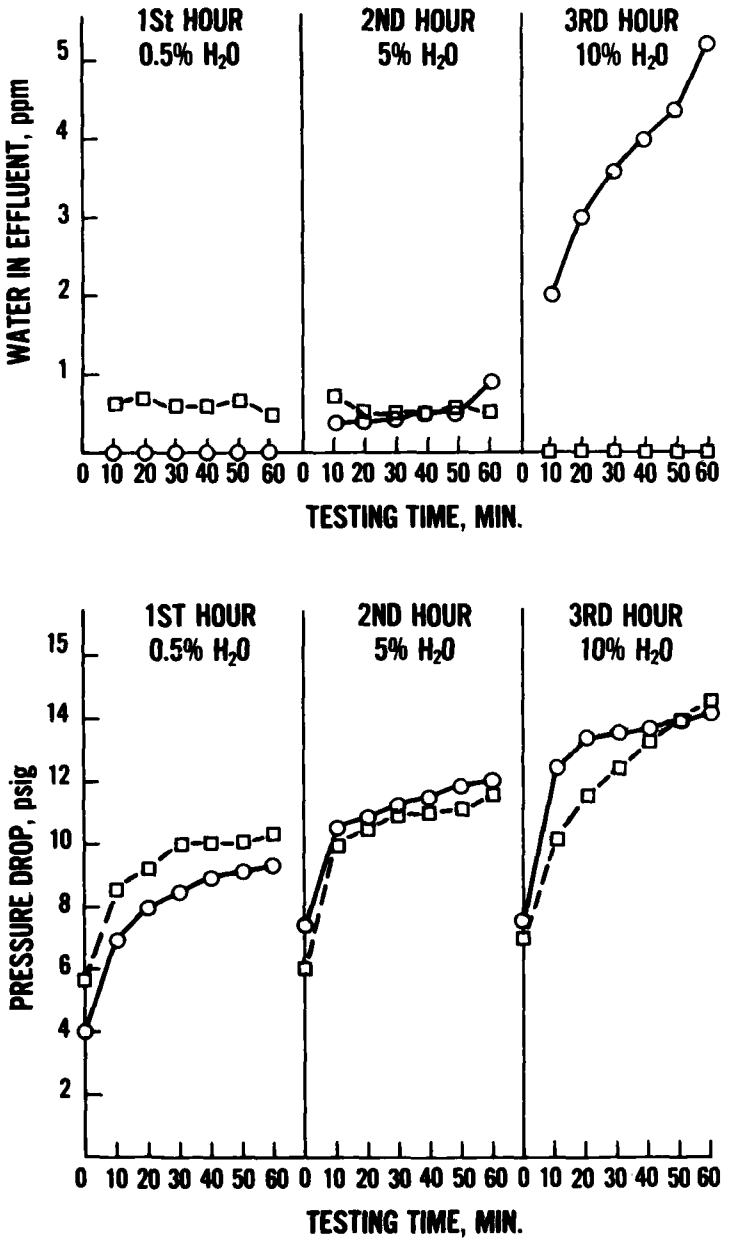


Figure 4. Test Series III, JP-5.

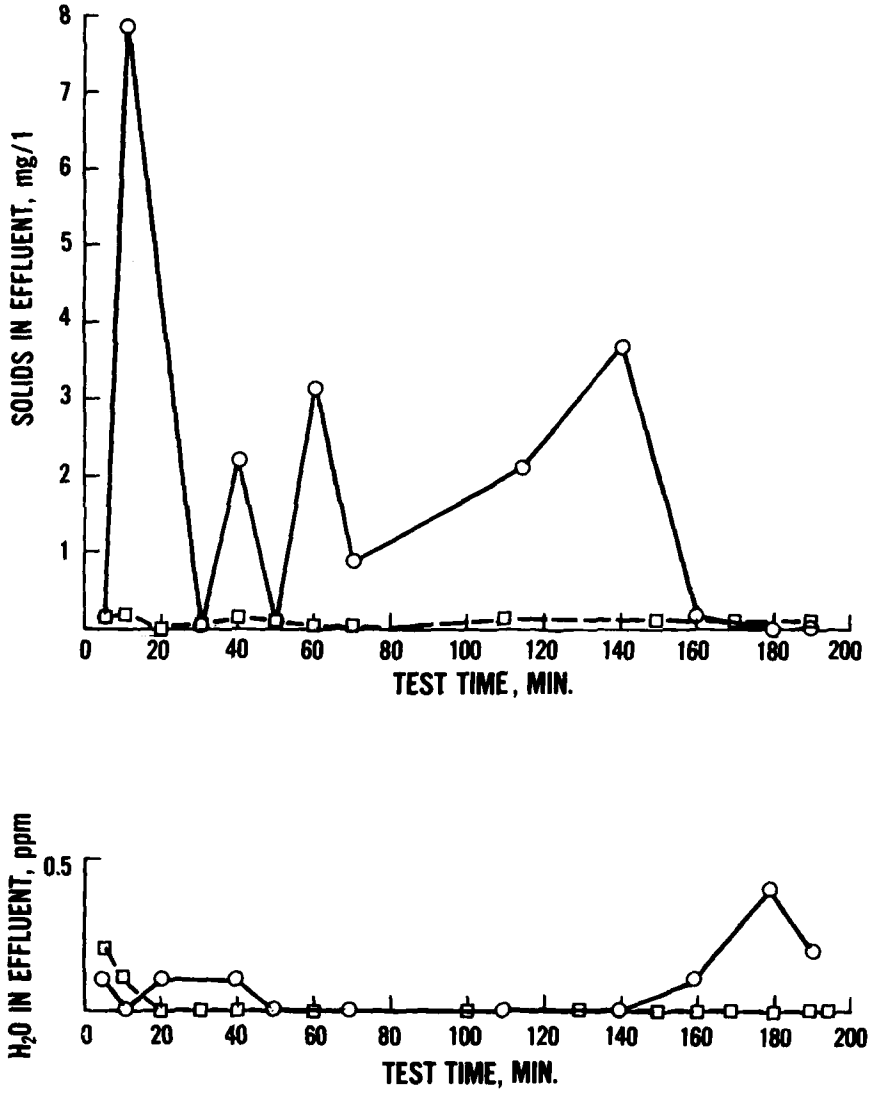
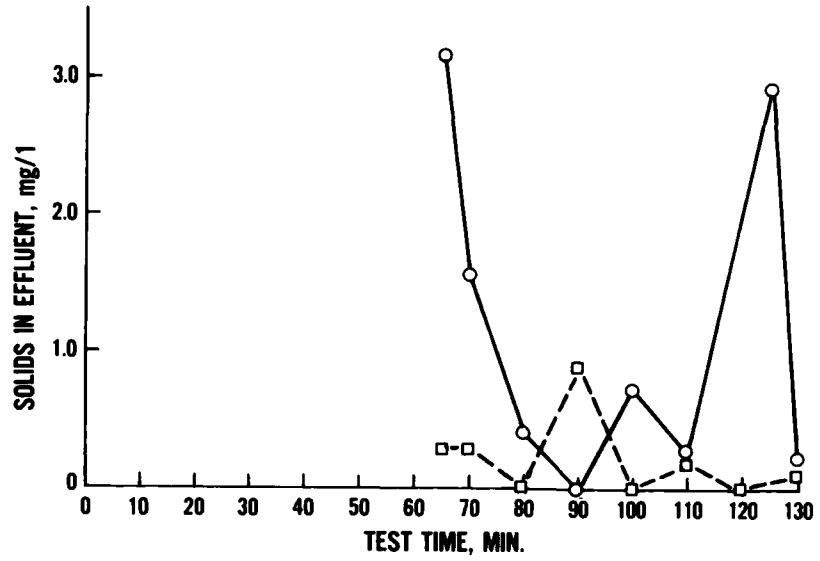
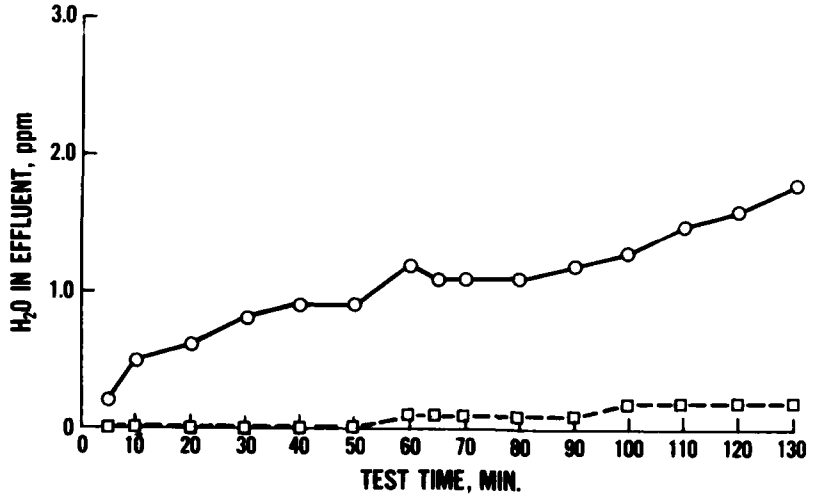


Figure 5. Test Series IV, JP-5.





TEST SERIES V
INHIBITED FUEL TEST
MIL-F-8901D PARA 4.4.3.10
NOMINAL FLOW RATE 40 GPM (100% RATED FLOW)
TEMP: 70–90°F
AC TEST DUST 0.143 g/gal

□— — JP-5 w/HITEC E-515 & AIA
○——— JP-5 w/HITEC E-515 & AIA 0.7 ppm ASA-3

Figure 6. Test Series V, JP-5.

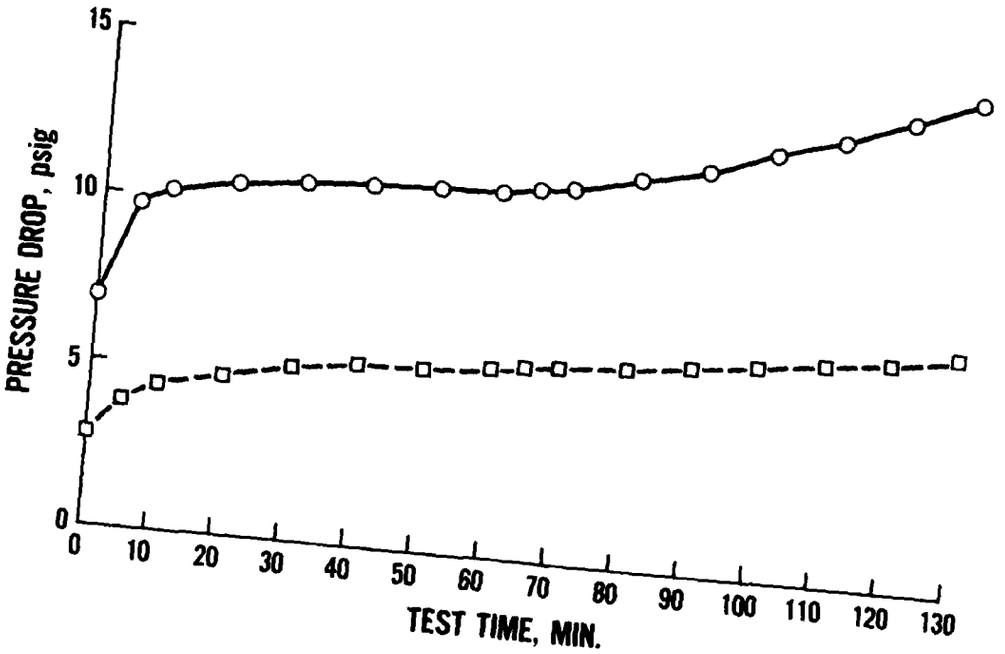
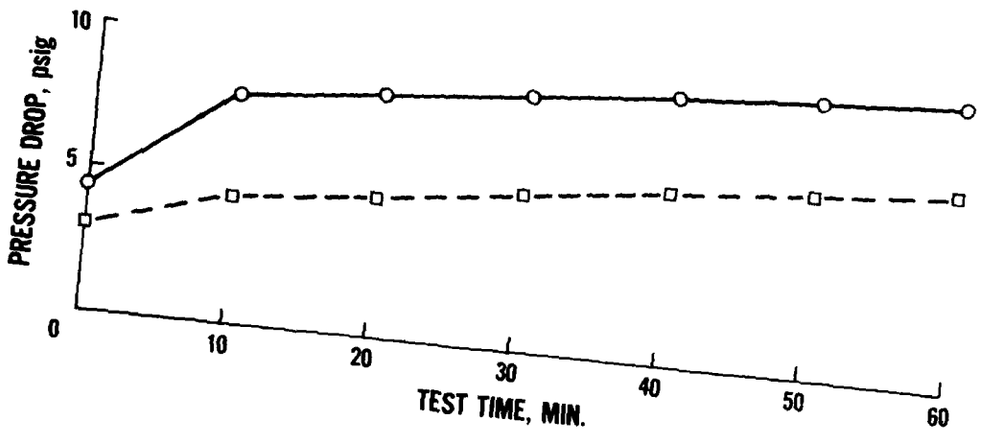


Figure 6. Test Series V, JP-5 (continued).



TEST SERIES VI
POST ENVIRONMENTAL
WATER REMOVAL TEST
MIL-F-8901D PARA 4.4.3.17
NOMINAL FLOW RATE 46 GPM (115% RATED FLOW)
TEMP 70–90°F
WATER INJECTION ON 0.5%

□— — NEAT JP-5
○—— JP-5 w/0.7 ppm ASA-3

Figure 7. Test Series VI, JP-5.

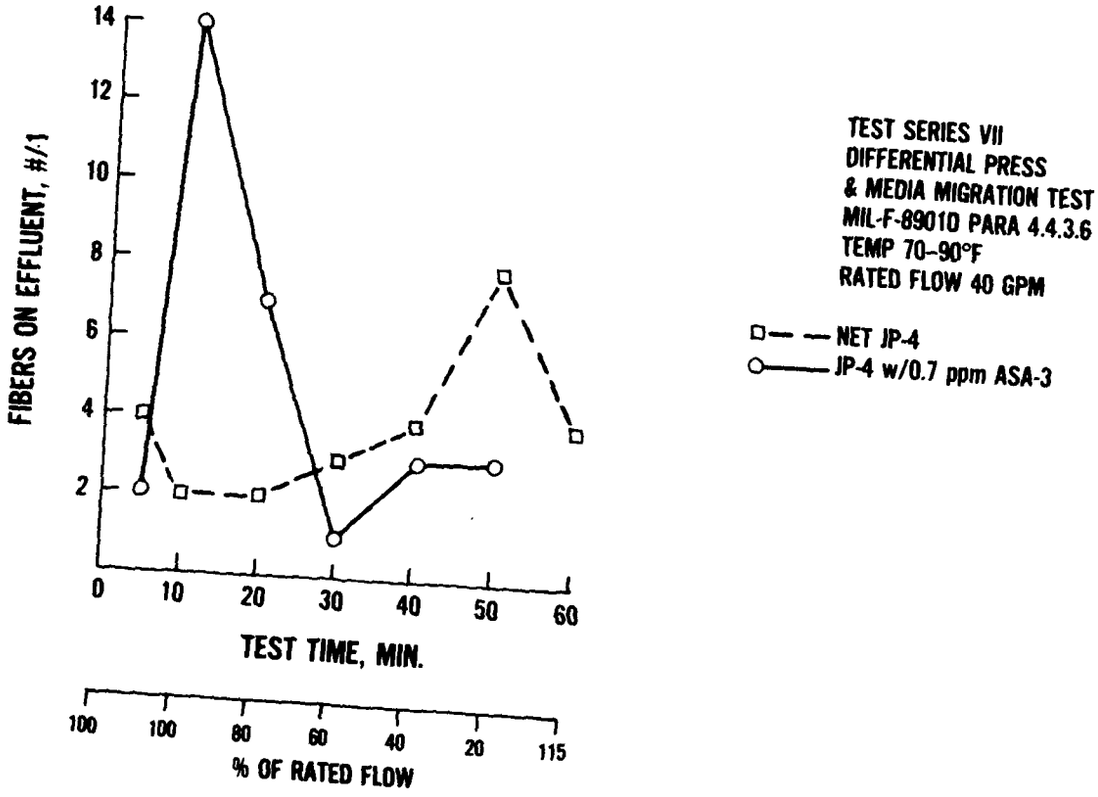


Figure 8. Test Series VII, JP-4.

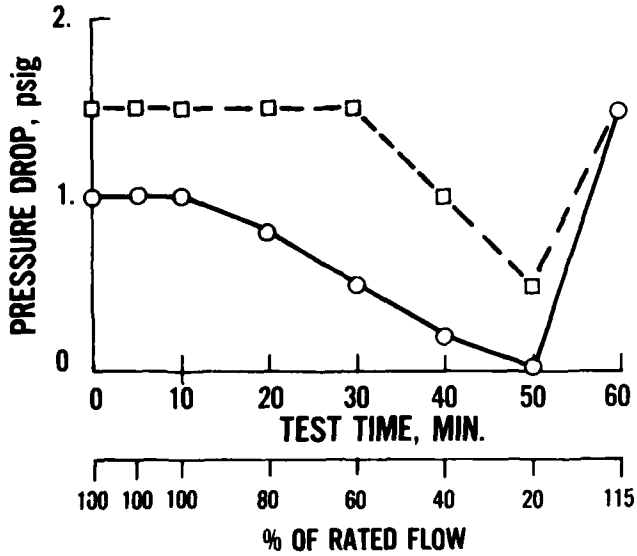


Figure 8. Test Series VII, JP-4 (continued).

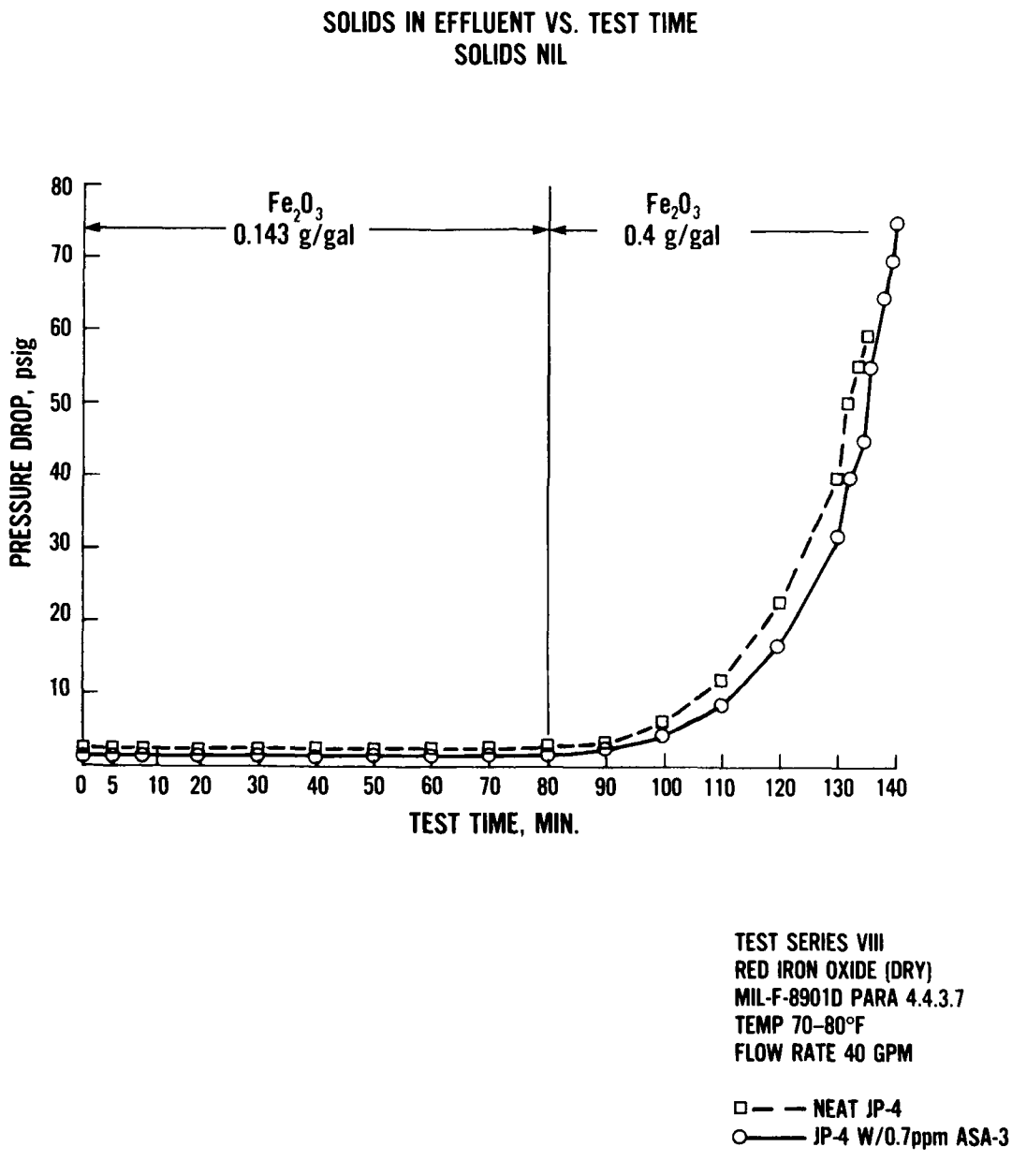
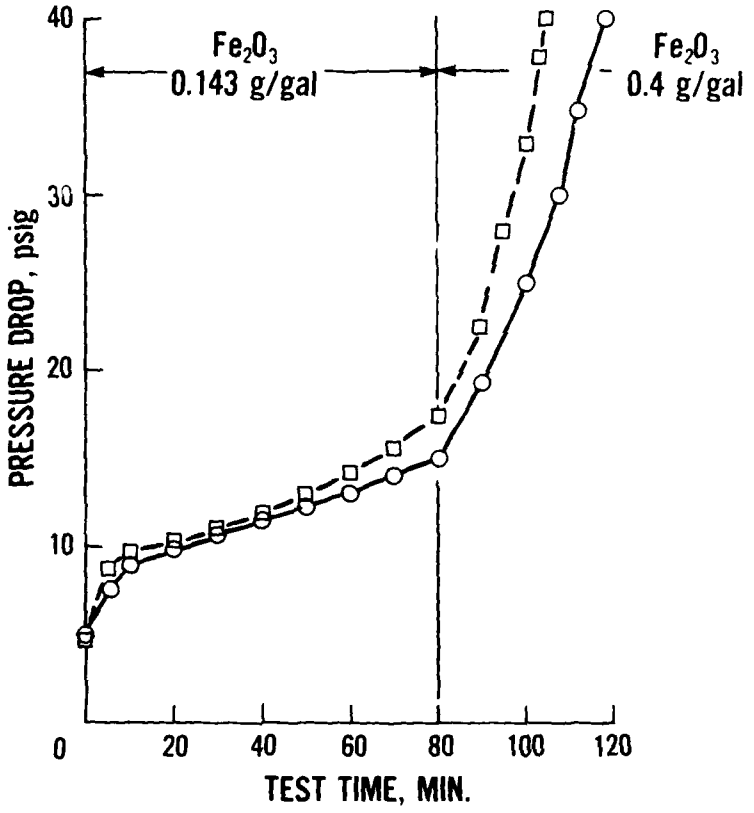


Figure 9. Test Series VIII, JP-4.



TEST SERIES X
RED IRON OXIDE AND WATER TEST
MIL-F-8901D PARA 4.4.3.9
NOMINAL FLOW RATE 40 GPM (100% RATED FLOW)
TEMP. 60–70°F
Fe_2O_3 ADD RATE AS SHOWN

□ — — NEAT JP-4
○——— JP-4 w/0.7 ppm ASA-3

Figure 10. Test Series X, JP-4.

Fuel conductivity was measured at intervals during each of the tests. Some of these measurements were discarded because of malfunction of the conductivity meter. Inspection of these values seems to indicate a reduction of fuel conductivity during the course of a test whenever red iron oxide was present.

IV. CONCLUSIONS

8. **Conclusions.** Based upon the results obtained, it is concluded that:

a. Equipment or procedural changes to the filter/separator operation will not be necessary when JP-4 containing ASA-3 is used.

b. Procedural modifications to filter/separator operation may be necessary when JP-5 containig ASA-3 is used.

c. The filter/coalescer test specification MIL-F-8901 has been modified to include the use of ASA-3 in the inhibited fuel test procedures on a "when specified" basis.

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